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DIGITIZED TROOPS IN THE BATTLEFIELD OF THE FUTURE

Lin Congrong

ABSTRACT: This article describes the concept of digitized information and digitized troops and their functions in the battlefield of the future. The weaponry and main technical foundation of digitized troops are also presented, in addition to the current status of development and prospects of digitized troops.

Key Words: digitized information, digitized troops, and digitized battlefield.

There are rapid changes in situations in the future battlefields. Real-time mastery of accurate information becomes the key factor of decision making of the combat. Therefore, the development of battlefield information resources has become increasingly emphasized by military circles of countries around the world. To meet the demands of future information warfare, military circles abroad are vigorously developing the digitized

information network of the battlefield. With applications of digitized information technology in weaponry, a brand-new concept of combat troops and combat style is taking form in the world, toward the battlefield of the 21st century. This is the concept of digitized troops that is attracting attention worldwide.

I. Digitized information and Its Application in the Battlefield of the Future

The concept of digitized information is using voice, letters, symbols, and graphics to describe information on battlefield situations, to be converted to 0s and 1s digital coding, which are compressed and processed to become the information to be transmitted. The main features of digitized information are as follows: it is easy to satisfy the requirements of secrecy; it is easy to form an integrated digitized network across the country, theater of war, and tactical combat units. High-speed computer bit communications can proceed, thus upgrading the quality of information transferred. Expert systems and high-speed displays can be used as supplementary means for rapid processing. Digitized information has extensive application prospects to the military. During the Gulf War, the digitized terrain information exerted important functions in missile precision guidance, air raid combat, command control, and ground combat. The reason for Tomahawk cruise missiles being able to hit targets at high accuracy is because digitized terrain information supports the operation.

Application of digitized information in the battlefield brings forward the battlefield revolution. By utilizing the known information on friendly units, information on the enemy, combat equipment situation, logistic preparations, as well as the information on combat environments in a conventional databank. Thus, combat units and combat personnel can share the battlefield information to realize the integration of information for all combat troops. Now the battlefield will not be in the traditional concept; its range covers the command post in the rear and the individual soldiers in combat. Digitization of battlefield information gives a new meaning to comprehension, coordination, and mutual support. To put it concretely, digitized information has the following important functions in the future battlefield:

1. Precision, time effectiveness, and capability for coordinated combat of the weapon systems can be upgraded dramatically.

Due to the results of information digitization, after electronic processing and correlation on target information acquired by sensors, the information can be distributed to various weapon platforms in digital form. Therefore, the target information can simultaneously and directly feed to the aiming device of various weapon platforms. With integration to the specific combat targets, the information is distributed precisely to each weapon platform in order to realize the optimal coordination among various weapons, thus it is expected that

combat effectiveness is upgraded by an order of magnitude.

2. It helps coordinated combat among various armed branches.

With rapid transmission, the digitized information can enable the exchange of target information in an instant among various service branches and armed units in combat, thus greatly intensifying the ground firepower, as well as upgrading the rate of air support and effectiveness. For example, the IVIS intervehicle information system of the U.S. Army can provide digitized information to helicopters through new data modems in helicopters on the acquired target information. Based on this information, helicopters execute attacks by using airborne weapons. Similarly, the observed enemy situation threatening ground troops from helicopters can also pass to the ground weapon system via the IVIS system so that the ground systems can quickly strike the enemy.

3. It helps in upgrading the combat command effectiveness.

It is feasible to apply digitized technology to modern battlefields, as follows: previously, a communication team composed of several skilled operators can transmit information by fixed communication facility with manual operation. Today, a skilled operator can perform the same job by using the automated mobile communication workstation. Previously, information (such as positions of enemy and friend, and geographic data) required many items of communication equipment; now, a handful of digital devices can provide the same information automatically. The large capacity digitized computer communication network can

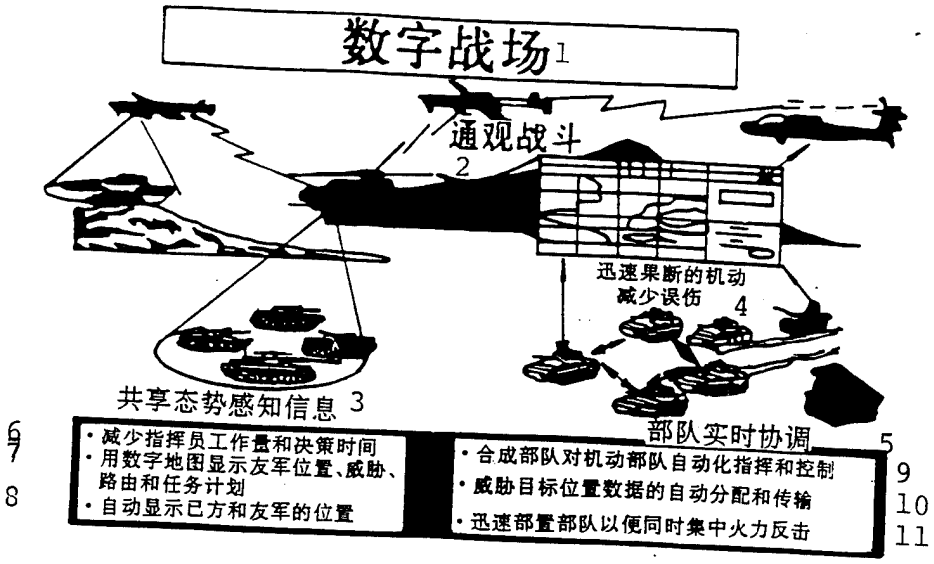
provide other key information to commanders and combat personnel, as follows: to distribute near-real-time digital information to various troop unit levels. These advantages greatly upgrade the speed, quantity, and quality of information transfer, are helpful to quickly prescribe correct combat plans by commanders, and the combat intentions can be quickly transferred to various levels of commanders.

4. It can greatly reduce friendly-fire casualties.

Previously, many systems could be used only to accomplish a specific mission with monolithic function, therefore it is easy to have friendly-fire casualties in combat. As indicated by analyzing friendly-fire casualty data of the U.S. armored vehicles during the Desert Storm action, if positions of the enemy, friends, and our units can be pinpointed, then attacks between friendly units can be greatly reduced. Since the digitized revolution of the army can share the most recent combat situation of troop units, the discrimination between friend and foe can be upgraded, thus reducing friendly-fire casualties.

II. Definition and Working Principle of Digitized Troops

Digitized troops are troops applying digitized communications. Such troops equipped with digitized communication facilities, vehicles, and ground weapon systems, connect the information reconnaissance, communication, command, and control in the battlefield into an organic entity, to sufficiently utilize battlefield information and to speed up the



Schematic diagram of digitized battlefield

KEY: 1 - digitized battlefield 2 - bird's eye view of combat 3 - sharing of situation and information 4 - rapid and decisive determination to move in order to reduce friendly-fire casualties 5 - real-time coordination among troops 6 - reduce the workload and decision-making time of commanding officers 7 - with digitized map to show friendly positions, threats, routes, and mission plans 8 - automatic display of positions for our side and allies 9 - automated command and control of mobile troops by integrated troops 10 - automatic distribution and transmission of position data on threatening targets 11 - rapid deployment of troops in order to concentrate firepower to counteract

combat activities in winning the victory in the battlefield. There is no distinction between the digitized troops and troops with conventional equipment in organization and structure. However, digitized information facilities are utilized in digitized troop units from the single soldier to armored vehicles, main battle tanks, self-propelled artillery, combat command vehicles, reconnaissance helicopters, attack helicopters,

close-support combat aircraft, as well as combat logistic support vehicles. In other words, audio and video frequency signals of various intelligence information in the battlefield are transferred and exchanged with digital coding through a device called the data compatibility demodulator, the battlefield information is transferred at a speed approaching real-time, thus greatly upgrading the reaction speed of battlefield situations, and quickening the combat pace of troops. The digitized facilities can realize the integration of information acquisition, transfer and processing of various armed branches and among various weapon systems so that the various combat factors in the battlefield become an organic entity. Thus, the combat capability of the enemy is greatly enhanced. Digitized communication also has the unique features of large communication capacity in unit time, long transmission range, high capability to resist jamming, and good encryption so that the enemy finds it difficult to know our activities, thus attaining the suddenness of battle combat. Thus, the enemy can be defeated because they are unable to make timely reactions.

II. Special Advantages of Digitized Troops

The special advantages of digitized troops are manifested mainly in the following aspects:

1. The speed of combat action can be quickened, thus seizing the battlefield initiative.

Mainly, digitized troops win the initiative and the victory

by more sufficiently and most quickly utilizing battlefield information to speed up the pace of combat. There is a significant gap in the decision-making of battlefield situations, and the pace of troop movements between digitized troops and nondigitized troops. Due to swift information, fast transmission, and correct decisions on the battlefield situation, the movements of digitized troops are very decisive and fast. Always, such troops can more in timely fashion to advantageous positions on the battlefield and can consistently maintain the initiative. The fast mobility and attack activities render the enemy defenses sometimes unable to take timely reaction. The reason is due to fast information collection and near real-time transmission, thus commanders can master the overall and accurate scene on the battlefield. They can decisively issue orders, and quickly concentrate combat resources in grabbing the initiative in the battlefield.

2. It upgrades the reaction speed and destruction resistance of weapons.

The digitized equipment greatly speeds up the reaction rate of weapon systems. For example, an M1A2 Abrams main battle tank with the IVIS intervehicle information system of digitized troops discovers an enemy target during an attack, and fire support is needed by field combat artillery; immediately the positions of enemy targets are transmitted with digital communication to the moving self-propelled howitzers. After the digital communication system of the self-propelled howitzers receives the information

(including combat diagrams plotted by computer with real-time transmission of enemy target positions at each instant), the main battle tank immediately parks along the roadside to wage concentrated firing and quickly destroy the targets.

3. It simplifies the command control procedure, and upgrades the overall combat capability.

In land combat of the 21st century, the ground troops will have more mobility, will require communication at longer distances, faster mobile combat, and utilizing of fire support by weapon platforms at longer distances. Due to the expansion of combat space and the increased fluidity of combat situation, it is required to have coordinated control of combat troop actions distributed in various directions and various areas to form overall combat firepower. In this respect, this demand can be satisfied by digitized equipment in acquisition, transfer, and processing integration of intelligence information. The information recognition, communication, command, and control in the battlefield are unified into an organic entity. U.S. digitized troops are equipped with data-compatible demodulators from M1A2 main battle tanks, Bradley Fighting Vehicles, Battle Command Vehicles (BCV), OH-58D reconnaissance helicopters in the air, Blackhawk helicopters responsible for command and control, and the airborne radar system of the tactical air force, thus an integrated air and ground digitized communication command network is formed to realize fast transfer of information from air to ground, and from left to right. Thus, command and control of

troops become simple and feasible. During combat, OH-580 reconnaissance helicopters transfer battlefield situation information through data-compatible demodulators to Blackhawk helicopters of the responsible command and control authorities. The helicopters pass the information to the vehicles (BCVs) commanded and controlled by the responsible ground officers, or the AH-64 air assault helicopters. The digitized ground vehicle information system (IVIS) connects with the guidance systems installed in each tank or armored vehicle to timely display with symbols on network diagrams in computer screens for the positions of our tanks on the battlefield so that the commanding officers of the M1A2 tanks can transfer the positions of our tanks. Thus, the commanding officers can command, control, and coordinate the tactical actions. When enemy tanks are discovered, by using laser rangefinders, the commanding officers can quickly and precisely pinpoint positions and distances of enemy tanks to be automatically displayed on screens of the IVIS system. Then, just by pushing a button the data diagrams of enemy tank positions are immediately transferred to other tanks, which instantly prepare to attack. Similarly, other tanks also can report to the commanding officers with a similar method, such as Report on Enemy Situation, and Report for Requiring Combat Service Support. All these are accomplished in an instant with real-time communication. The receiving of such prospective diagrams by moving the armored mechanized troops is a major superiority of the digitized system, so that the tank mobility

can be carried out in the situation of real-time information transfer without any delay. Thus, the commanding officers enhance the command and control of mobile troops.

4. It upgrades the acquisition and transfer of information.

Digitized technique can quickly and accurately transmit battlefield intelligence to commanders under silence with pictures and letters at the appropriate time; this intelligence are acquired by reconnaissance soldiers in the battlefield. In addition to the M16A automatic rifle fitted with infrared night aiming lens and the model PVS-7 night vision eyepiece (a picture enhancer capable of enhancing and magnifying visible light at night, thus seeing objects at night that the eyes cannot see), there also includes a key picture reconnaissance and transmission system installed in a television camera with 8mm lens at the upper left of his helmet. A microcomputer screen (video display terminal) and a cigar-box size microcomputer are fixed in front of the soldier's right eye. The control keyboard of the computer is located at the right of the ammunition belt. Just by pushing the keys on the keyboard, the soldier's battlefield scene can be transmitted in real time to a Bradley fighting vehicles or command vehicles in real time. The microcomputer carried by the soldier can store eight frames of battlefield pictures and four reports for transmission when required. The digitized technique enables the soldier to report the enemy's situation to commanders when he conducts close reconnaissance for long-term surveillance of the enemy at very close distance in complete silence.

5. It is convenient for protection of combat services and first aid in the battlefield.

The global positioning system of equipment for digitized troops can provide orientation and digital information for all personnel with access to the system. At all times, every tank, every armored vehicle, and every soldier knows their position in the battlefield, capable of requesting battle support or combat logistic support from the rear based on combat requirements. If a soldier is hurt, his life can be saved with a brand-new way. The GPS enables the troop unit to know the location of the casualty in the battlefield in timely and accurate fashion so that the first-aid team can quickly ride a helicopter or a first-aid vehicle to reach the location of the casualty for first aid under GPS guidance. Even more astounding, a television camera in the casualty's helmet can transmit the location and the injury status via pictures to the battlefield first-aid center. Thus, the mutual aid activities in the battlefield can be instructed by the first-aid center tens of kilometers away or military surgeons on the way can make some first-aid measures before doctors arrive on the scene because the digitized communication network provides television pictures at all time. Thus, precious time can be saved in order to save many soldiers that would lose their precious lives based on conventional communication modes and conventional first aid procedures.

IV. Weapon equipment of digitized troops

1. Digitized soldier system

The digitized soldier system mainly includes a television camera fitted on his helmet, and a microcomputer fitted in front of his right eye. The microcomputer is only the size of a cigar box; by just pushing a button, limited quantities of information can be transmitted. In addition, there is a GPS receiver for single soldier, a night-vision device, and a communication system. The television camera is 8mm in format, used to take pictures of an object. A micro-display can be used to display pictures and to provide still pictures for commanding officers in combat vehicles. The microcomputer is used also to store pictures and videos. The GPS receiver is used to tell the exact location of the bearer. The night-vision device is used to capture targets and combat at night. The communication system is used to transmit digitized telegrams and pictures. As verified by experiments, the digitized soldier system can enable the soldier to be more effective in combat, especially when he carries out reconnaissance missions. With the system, the soldier can silently accomplish his mission of monitoring the battlefield and transmit digital information to his upper echelons when he is very close to the enemy. Thus, the commanding officers do not need much time in estimating a situation, thus enhancing the command and control efficiency to a greater extent.

2. Digitized weapon system

There are the following types of digitized weapon systems

under development and modification at present, by the U.S. Army:

(1) M109A6 self-propelled howitzer

The howitzer is the newest improved version in the M109 series self-propelled guns. Such howitzer adopts a vehicle-borne trajectory computer and guidance system; both are digitized equipment. Digitization of the howitzer can have faster response to calls for fire support than the M109A3 version. The M109A6 self-propelled howitzer usually can receive a mission while in motion to set up a fire base along a roadside before firing and then move again. The entire process can be completed within 2min. However, the same procedure requires 20min for the M109A3 version. The navigation guidance system can tell the crew at all times the precise location of the gun so that the howitzer can have more survival opportunity under the enemy's artillery suppression firepower.

(2) M1A2 main battle tank

The refitted M1A2 main battle tank equipment includes an IVIS intervehicle information system, which is the most recent development applying the digital technique and software technique, connecting a small display controlled by computer, and a radio system, capable of transmitting data information and picture with sudden bursts of digits via a tactical radio network for communication between vehicles. In addition, the IVIS system can automatically provide location data for vehicles within a combat unit, and this data is shown on a screen with graphics. The IVIS system is connected to the vehicle-borne guidance

system, so that every tank commander can consistently know the location of his tank and can track the position of friendly tanks with the same system. The location information is displayed on a grid map on a computer monitor. When applying accurate location positioning of enemy vehicles, the tank commander can obtain their position data with a laser rangefinder. These data can be displayed on an IVIS system monitor. By pressing a button, the platoon leader in the vehicle can transmit the digital map with locations of friend and foe to other tanks. Similarly, any tank commander can use the system to transmit a formatted report. The report contents may include precise locations of enemy target and much other information for logistic requests.

(3) Combat command vehicles

The combat command vehicle is also equipped with the IVIS intervehicle information system. This kind of command vehicle has a chassis of multibarrel rocket launcher. Over the chassis, an enclosed body like a large van. Within the combat command vehicle there are work panels for officers responsible for command, combat, intelligence, and fire support. Software system and communication facilities are installed in the vehicle so that four major personnel of the command and staff team can make faster decisions than the present command decision making system of brigade level and battalion level. At present, the software function of such combat command vehicle is still not high, and there is the apparent information feature in the battlefield. These points remain to be further improved.

3. Digitized communication system

The system is the main equipment of digitized troops. The digitized information system can transmit in real time the battlefield intelligence (information in various media) with digital code to various combat units. Five new digitized information systems were developed by the U.S. Army for future information warfare.

(1) Single-channel ground and airborne radio system

The system is for command control by commanding officers at the battle front to provide radio communication with reliable antijamming and secure combat network. There are three types: backpack type, vehicle-borne type, and airborne type. The communication frequencies of the fundamental station of the system are between 30 and 87.975MHz with 2320 useful channels. The system weighs 8.4kg, and the communication range is between 8 and 35km. The U.S. forces plan to purchase 180,000 sets of such systems, including 141,500 sets for frontline troops and 38,500 sets for other troops. Each army division will have 3500 such stations. At present, army divisions have been equipped with 28,000 sets.

To enhance system performance, the U.S. Armed Forces are enhancing the capability of data communication and positioning reports in the system, interfacing with public communication systems along with weight reduction and operational simplification.

(2) Data distribution system for the U.S. Army

This system is a data communication system for command and control at the division level and army level of the U.S. Army, to provide near-real time data distribution in the expected electronic jamming environment in order to enhance the mutual communication capabilities of battlefield information systems. The data distribution system is composed of an enhanced version positioning report system and a unified tactical information distribution system. Its principal feature is to use time-division multi-addressing technique, capable of conducting rapid data communication within 4s in addition to preventing jamming during transmission. Frequency agility and expansion frequency techniques are applied with higher antijamming capability. The weight is low; a backpack type positioning report receiver weighs 10kg, and a terminal of a unified tactical information distribution system weighs 34kg.

(3) Milstar military strategy and tactical relay satellite system

The system is composed of a terminal for mobile type tactical satellite communication, and a fixed-type strategic terminal that is mobile. The system can provide uninterrupted over the horizon communication for tactical troops units in order to ensure integrated combat in the air and on the ground. The U.S. Army mainly develops Rascal single-channel, antijamming back pack type terminal, and Smart-T mobile secured antijamming and reliable tactical terminal to ensure the requirements of using Milstar for tactical communication.

The Rascal is a low-data-rate satellite communication terminal, operating in a very-high-frequency band, capable of transmitting 75 to 2400baud of voice and data. The terminal is light in weight; the prototype weight is 13.6kg, and the improved version is between 5.44 and 6.8kg. The beam is narrow, capable of reducing the probability of being detected. Therefore, the terminal is used mainly to expand the communication distance for command control main links and long distance reconnaissance teams and Special Forces.

The Smart-T terminal is a high-mobility, multifunctional, wheeled vehicle-borne satellite communication terminal, providing medium- and low-data-rate voice and data communication for tactical users. The terminal is secure, with capability of antijamming, in addition to expanding the communication distance between mobile user equipment systems of the army-level and levels lower than army in the U.S. forces.

(4) Mobile user equipment system

This is a tactical regional communication system as the largest in U.S. Army history, as the most modern secure, automatic highly mobile, fast-deployable, and destruction-resistant. The system can provide data, voice, and facsimile communication to the entire combat area of a division and/or army. The system applies the pan-search route and gain-modulation technique, capable of realizing battlefield coverage of mobile and fixed users, wherever the commanding officer and staff personnel move, to use a fixed telephone number for

communication. The transmission rate of each channel in the system is 16kbaud. An equipment network of mobile users can ensure the regional communication over an area 150km by 150km accommodating a field army of five divisions in communication.

(5) GPS

The system is a joint development program of the U.S. Army, Navy, and Air Force, mainly consisting of user receivers and guidance satellites. In the program, the Army leads in being responsible for developing back pack type receivers, vehicle-borne receivers, as well as airborne receivers of low and intermediate performance. These receivers will be extensively furnished to all units of the Army. Intermediate and small-sized airborne receivers have been verified in experiments. Moreover, the U.S. Army combined the GPS function into the communication and guidance system of its main platforms in order to upgrade the comprehensive communication capability of these equipment systems.

V. Main Technical Foundations of Digital Troops

Digitized troops are products that information processing technology is applied in the communication system of ground main battle weaponry. The major technical fields related to digitized troops include high-speed microcomputer technique, digital coding technique, digital synthesis technique, digital compression technique, and digital modulation and demodulation technique. The information technique, especially the information processing

technique, is always an important field that nations compete to develop. At present, in the world the information superhighway project is being realized. The project objectively stimulates programs of information systems of the Armed Forces for various nations. Some achievements have been attained in the process of carrying out the information superhighway program, such as the compression technique of communication data. These achievements support technically the program of digitized troops.

1. High-speed microcomputer technology

A high-speed microcomputer is the core technique of digitized troops. Since it is flexible to apply, with unique features of small size, light weight, low price, and high reliability, high speed microcomputers are generally stressed by armed forces abroad, with extensive applications, militarily. Microcomputers have been extensively used in command, reconnaissance, military training, automatic control of weapon systems, automation of logistic management of troops, military communication, and electronic countermeasures. In the Gulf War, three branches of the U.S. Armed Forces applied large numbers of various microcomputers, workstations, and local area networks consisting of microcomputers so that various vehicle-borne, airborne, and shipborne command systems are conveniently formed. The command center of the theater level also used large numbers of high-tech command facilities with microcomputers as the core. At present, the main microcomputer technique is to develop very-large-scale integrated circuitry, upgrade hardware performance,

expand directly-addressed memory, and enhance input/output processing capability in order to meet the requirements of encoding, decoding, encryption, decryption, and upgrading information reliability for the digital communication system. The Pentagon is stressing the development of superhigh-speed integrated circuitry. It is estimated that the capability of electronic computers will be upgraded by 1 to 2 orders of magnitude, power consumption reduced by 80%, size and weight reduced by 70%, operating speed raised by tenfold, and cost reduced by 90%.

The multimedia technology is an important aspect for the development of computer technology; this is also the key research content of foreign armed forces at present. The multimedia technique is a technique that can carry out digitized processing of information of multiple carriers or memories. By using this technique, computers can integrate language, voice, and pictures, thus becoming capable of transmission, recording of information indicating voice, pictures, and letters. This will be a new leap forward of information processing capability of mankind, to integrate voice, images, digits, and charts for combat command, combat simulation, and intelligence, for more real time, higher effectiveness, and closer realism. The key research of multimedia technique mainly concentrates on multimedia creative tools, digital audio frequency technique, digital video frequency technique, digital compression technique, conventional multimedia software platforms, and virtual reality technique.

2. Digital encoding technique

Digital encoding uses digits for coding, generally in binary or octadecimal format. The digital encoding technique is an important component part of digital communication. Based on different missions, the technique can be divided into channel encoding, information-source encoding, and secure encoding. Channel-encoding aims at upgrading communication reliability; it is also called antijamming encoding or error-control technique. The central problem in the channel encoding technique which includes the property and structure of studying error detection and error-correcting code, as well as the realization of software and hardware encoding/decoding. Signal-source encoding aims at solving the problems of digitizing simulation signals and upgrading the effectiveness of digitized signals; pulse code modulation and gain modulation is the most fundamental encoding forms of signal source; both have been extensively applied in military communication networks and aerospace communication systems. To a great extent, signal-source encoding technique develops in compressing the encoding bit rate because the encoding bit rate directly affects bandwidth of transmission during communication. However, the bandwidth of transmission directly indicates communication economy. Secure encoding aims at carrying out secure communications to encrypt signals after signal-source encoding. At the receiving terminal, decryption is executed. Development of secret code techniques is decided by secret code algorithms and secret keys. At present, in-depth

studies are underway by the U.S. Armed Forces on technical problems of the several above-mentioned encoding forms in order to make a breakthrough in technology.

3. Data synthesis technique

Data synthesis is accomplished by machine for comprehension and/or illustration of data for display and expression with the most-easily accepted form. Its military application range is from signal collection by sensors to comprehensive display of information in aircraft cockpits, and from simple weapons to large scale information processing and combat management. Therefore, data synthesis is an important integral part of various military information systems. The purpose of developing this technique by U.S. forces is to apply comprehensive processing of information data obtained by various sensors regarding types, locations, and mobile situations of targets.

With respect to the principles of the future integrated war of air and ground, U.S. forces will realize command and control over multiple-dimensional target information. Since the study of data integration technique provides the foundation of information processing and sensor management on air reconnaissance systems, the advanced smart weapon systems, and command center supported by highly advanced computers, therefore the final purpose is to achieve the upgrading of the effectiveness of the C^3I system to satisfy the information demand by the modern combat management. The Pentagon will demonstrate with multiple assumptions and deductions in the next two years. Demonstration of maritime

synthesis on data of ground and airborne sensors will be conducted on ships.

4. Data compression technique

Data compression involves compressing the data to certain proportions to be used for the transmission of intelligence and graphics information. The present data compression rate is about 30:1 in the U.S. forces. This compression rate is unable to satisfy the requirements of information processing in modern warfare. During the Gulf War, reporting on combat requirements was delayed because of slower speed of transmitting two levels of images. By advancing the advanced compression technique, the data compression rate may reach as high as 1000:1. Such high compression rates can greatly shorten the image transmission time. For example, in the 2.4kb/s channel, 2h is required to transmit 17Mb of images (corresponding to the quality of magazine pictures); 7s is required if the advanced compression technique is applied. It is possible in the near term that the speed problem on image collection, processing, and transmission can be better solved by the U.S. forces.

5. Digital modulation and demodulation technique

Modulation and demodulation is the basic integral part of a digital communication system, with an important effect on system performance. Modulation involves converting the input data signal of fundamental band into the frequency band signal more suitable to information channel transmission. The most common and the most fundamental form of digital modulation is to apply

sine wave as the carrier wave in digital modulation, such as modulations of oscillation amplitude, frequency, phase, and combinations thereof. Demodulation is the reverse conversion of modulation; its functions are to discriminate the frequency band digital signal with distortion and noise after transmission through a signal channel to determine the original digital signal represented by signal waveform of each code element, and to restore the original digital signal. The most fundamental requirements of digital modulation and demodulation are the following: (a) suitable to properties of signal channel; (b) it occupies a narrow frequency spectrum with small radiated power outside the frequency band; (c) it has higher frequency-band utilization rate; (d) it is high in antijamming. Under the requirements of a given rate of error code, the required normalized signal to noise ratio is lower than E_b/N_0; and (e) it is simple to carry out.

At present, the improved version data modems are under production by the U.S. Army in order to share the received signals with other armed branches. The performance of this improved version data modem is better than the CP-1516/ASQ airborne target information automatic transmission system that the U.S. Army uses at present, the improved version can simultaneously transmit and receive radio signals from four channels; the data rate of each channel is between 75 and 16,000bps. This modem can transmit real-time information to vehicles, helicopters, joint surveillance and target attack radar

systems, as well as various operations centers throughout the world.

VI. Development Status and Prospects of Digitized Troops

Digitized troops are a development of recent years. After the Gulf War, to meet the challenge of information-era warfare, the U.S. Army proposed the concept of building the army of the 21st century. The concept includes a series of new viewpoints of digitized troops and winning the information warfare on the battlefield. Moreover, a series of combat laboratories were set up; small-scale digitized troop units were organized; real combat demonstrations between digitized troops and nondigitized troops began; and time schedules for carrying out digitization throughout the army were drawn up. Between April 10 to 23, 1994, a demonstration, code-named Desert Iron Hammer, was conducted by the U.S. Army at the National Training Center in California. Combat exercises were conducted between the 1-70 Special Forces unit and the Third Mechanized Infantry Brigade of the 24th Mechanized Division, on one side (with digitized equipment), against the 177th Independent Armored Brigade without digitized equipment. Various combat activities were continuously executed day and night with reconnaissance and counter-reconnaissance, mobility and counter-mobility, destruction and counter-destruction, as well as penetration and counter-presentation. This demonstration revealed some features of the ground battlefield in the future high-tech conditions; this is also

called the digitized battlefield. The demonstration aroused great interest from the press and military of nations around the world. With striking headlines in the European edition of Stars and Stripes in the United States: "This is the embryo of the army toward the 21st century. The future battlefield will be a digitized battlefield." As pointed out by Jane's Defence Weekly in the U.K., "as indicated by the actions of U.S. forces in experimenting with the digitized troops, the U.S. Army is to find a combat form to win a 21st century war with fastest speed and smaller casualties." By quoting the words of those taking part in the demonstration troops in Army Times in the U.S., "the digitized troops have three times the potential combat power of conventional troops."

In building up the digitized troops, the U.S. takes advantage of its leading position in military information technology; it was the first to conduct experiments with a certain scale of digitization. In-depth research will be conducted on data acquired in the combat exercise by the six combat laboratories of the U.S. Army in order to benefit the buildup of digitized troops. In the words of General Wister, secretary of the army [sic]: "We bet the victory in war in the next century on digitized technology."

The U.S. Army plans to put a completely digitized division in the battlefield in 1997 and in 1998. In 1999, a completely digitized army is to be placed on the battlefield. Before 2010, the entire army will be digitized. Therefore, the U.S. Army will

invest more than 2 billion U.S. dollars to conduct digitized remodeling of the weapon equipment systems of the Army. As the first step under this program, in 1996 a completely digitized heavy armored brigade will be deployed. In that year, an exercise code-named Brigade of 96, will be conducted at Hentenburg, Texas. There is no difference in the organizational structure from the heavy armor brigade of conventional equipment. The purpose is to find the troop structure that can exploit the highest combat effectiveness in order to push innovation of combat troop structure in the Army. Recently, the U.S. forces decided on seven key techniques of digitization in the Army Aviation of the future. Of these seven key techniques, there is photography and television receiver system, which requires immediate transmission of battlefield images photographed by Army Aviation in the form of still frames to ground command posts, as well as to the Army paratroops command and control centers at different transmission rates. The improved version data modem will be provided in aircraft of the Air Force and the Marine Corps, to be the key element of the digitized information network among airborne platforms. Moreover, the U.S. forces acknowledge the integrated signal and data network (ISDN) as the developmental direction of the next-generation strategic communication network. Resourceful information technical foundations are also possessed by some developed nations in the world, such as the U.K., France, Germany, Russia, and Japan. Some of their most advanced main battle tanks also have digitized

communication equipment. Moreover, such key item of equipment as the data-compatible demodulator is also under development in these nations in order to solve the real-time communication problems between arms branches and weapon systems.

The future battlefield will be the digitized battlefield. The emergence of digitized troops and applications in battlefield forecast the coming of the digitized era of the battlefield.

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